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CALFED EWA Gaming: Water Quality Notes
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Role of water quality actions in CALFED EWA Gaming

As new facilities and operation rules are developed and gamed, consideration of Delta water quality and delivered water quality to sensitive users must also be considered, primarily because water quality can so easily be influenced by operations.

Delta water quality: Constituents of concern, control mechanisms, and causality

For drinking water suppliers utilizing the Delta as a source, bromide, chloride, TDS, and organic carbon are the major constituents of concern. Elevated levels of bromide and organic carbon in source water can affect disinfection byproduct formation, several byproducts are regulated by the U.S. EPA and the State of California. General saline compounds in source water, as measured by TDS concentration, are of additional concern because of the impact to conjunctive use projects (ie, ground water recharge). High levels of TDS can also damage appliances and piping. Chloride ion concentration is another general indicator of salinity in Delta water and higher levels can be aesthetically undesirable.

The highest bromide, chloride, and TDS concentrations in the Delta appear in the fall of drier years due to seawater intrusion resulting from low Delta outflow. In wetter years the peak values of bromide, chloride, and TDS can actually occur in the late winter due to agricultural and urban runoff. However, the wet year salinity peak is about half as high as the dry year peak. Total organic carbon concentration in the south Delta is about 3.0-3.5 mg/L for most of the year with peaks of 6.0-8.0 mg/L occurring in the late winter (February to March) and lasting 4 to 5 weeks.

CALFED gaming assets and use

Water quality assets in the gaming were largely financial, allowing the water quality interests to purchase water in the fall to enhance outflow when export pumping modified Delta outflow for some other purpose. This action was largely independent of the gaming, so to a large extent it was post-processed after the gaming when the magnitude of the impact was known.

Outflow enhancement was a particularly useful mechanism for affecting salinity in the fall months but other assets such as actual control of a finite water quantity south of the Delta would have allowed other actions. For example, if the water quality interests had control of water (or collateral) they could effectively limit the amount of pumping in the fall and winter months when salinity or organic carbon concentration was high in the Delta to reduce the export load. These interests would then have the collateral to repay forgone exports with real water to offset the filling risk to San Luis Reservoir caused by

the restricted pumping in the previous months. In principle, this is analogous to the Environmental Water Account except with a different benefactor.

Water quality assessment: results from recent gaming (Games 1A, 1B)

Salinity: Salinity was evaluated mostly with the G-model, a relatively simple model which relates Delta outflow to interior Delta salinity, and DWR's Delta Simulation Model (DSM2). The south Delta was the primary focus area with output from the gaming (and DWRSIM studies) being used to run both models. In Games 1A and 1B (late 1999), DSM2 was used in the salinity assessments, primarily to allow consideration of agricultural drainage and operation of the Delta Cross Channel in addition to effects related to Delta outflow, export operations, and Delta inflow.

It was found that salinity impacts that occur in Game 1A and Game 1B during the fall months are caused by closure of the cross channel and outflow reductions. Typically these increases to salinity were in the 20-50% range in December and January relative to the Accord levels. In drier years impacts are larger; there were a few instances when increases in salinity were twice as high in fall months of drier years relative to the Accord. In wetter periods (periods with high outflow), there was typically no effect on salinity in the south Delta. The DSM2 simulations assumed closure of the Delta Cross Channel throughout October and November, an assumption used in the hydrodynamics modeling that was more aggressive than the fishery agencies requested in the actual gaming. For this reason, the salinity impacts from the gaming calculated with DSM2 may be overestimated in October, November, and December.

Adjustments to outflow in the fall will affect salinity in the south Delta if the Delta has been in balance in the preceding months. As a general rule, any operation which directly or indirectly results in less Delta outflow when outflow is below 5,000 to 10,000 cfs could have adverse impacts on salinity. The possibilities of salinity reduction in exports and diversions resulting from Delta island storage need more study. During high outflow periods a different mechanism operates. TDS, chloride, and bromide concentration at CCWD's intakes can actually be reduced through increased exports in high-outflow months depending on the timing and location of drainage events and position of the Delta Cross Channel gates. More study is needed though.

Shifting exports out of the fall when salinity can be highest will effectively reduce export salinity load. However, this export shifting can risk water supply. If the winter months are dry then San Luis Reservoir may not fill before export demands are at their peak. In this case allocations to contractors in the present year can be affected.

Organic carbon: Results from the gaming showed that the export shifting from winter to the summer and fall tends to reduce export organic carbon load by about 5%. The reductions to quarterly averages of organic carbon are larger, primarily because exports during the peak in organic carbon period in the south Delta are reduced. Contributions from the operation of in-Delta storage were not included because of the difficulty in assessing the amount of organic carbon uptake that would occur from the peat soils after

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the water has been stored for several months. Another difficult parameter to evaluate is the portion of the stored water that reaches municipal intakes after being released from Webb Tract or after being exported by the Banks or Tracy Pumping Plants.

In the gaming exercises Bacon Island releases were assumed to be directly conveyed to the export pumps while Webb Tract exports would be pumped back into Delta channels. As gamed, Bacon Island operations have the potential to increase TOC in exports due to the timing of the diversions to storage and the interaction between peat soils and shallow water storage. The extent of this effect needs more study. Unlike Bacon Island releases, Webb Tract operations could increase the organic carbon load at Banks Pumping Plant and CCWD's intakes. In some of the gaming exercises, water was stored for longer periods on Webb Tract compared to Bacon Island, where at times, the existing exports were simply shifted to Bacon Island to provide a better screened diversion for fishery protection. This resulted in shorter storage periods on Bacon Island.

An interesting result from the gaming relates to the tradeoff in export load of salinity and organic carbon. Export reductions in the winter and early spring can reduce export load of organic carbon but if that pumping is shifted to the fall months (typically the only period when export capacity is available) then the salinity load of exports can be increased. However in some wet years (e.g., 1998) the highest salinity of the year can occur in the winter months so this shifting could be a net benefit.

Outlier issues and role of common programs

There are many possible CALFED Stage 1 actions which could influence water quality that were not evaluated within the gaming exercises. These actions would need to be integrated for a complete Stage 1 assessment. These actions include:

- Barriers in the south Delta (e.g., head of Old River, hydraulic barriers)
- CALFED water quality common programs (e.g., agricultural drainage re-location and/or treatment, land use changes)
- Delta cross channel operations
- Delta Island storage

Example Water Quality Assets for Stage 1

Increase Delta outflow in the fall. Many of the assets that generate new water for supply purposes or for environmental use can be used to improve water quality. To the extent increased outflow improves habitat for fisheries in the fall (attraction flows, decreased salinity in the Delta, etc.) outflow enhancements could be counted as a benefit for both the ecosystem and water quality.

> ***Example***: Increase minimum required outflow in September through November when outflow is low enough to cause significant seawater intrusion. A 500 cfs increase in Delta outflow for 3 to 4 months (90-120 TAF) could provide significant water quality benefits (lowering chloride concentration by 30-50 mg/L when levels are already elevated). The simplest and most effective method for implementation would be to lower the maximum allowable chloride concentration at Rock Slough or some other compliance location which could act as a general indicator of seawater intrusion into the South Delta.

> **Operation rule:** The maximum allowable chloride concentration at Rock Slough could be lowered from 250 mg/L to 225 mg/L. This method would ensure that outflow was only increased when it was actually needed (under some conditions salinity in the central and south Delta can be low even though Delta outflow is low due to antecedent salinity conditions).

Operate Delta Cross Channel. This action would utilize discretionary use of the cross channel gates to improve quality if there was no significant impact to fisheries. Although closure of the cross channel gates will benefit up- and out-migrating salmon under many conditions, closure of the gates can under some circumstances negatively impact water quality in the central and south Delta.

> ***Example***: Delta Cross Channel gate operations in October, November, and December could be critical to south Delta water quality if outflow is low and exports are high. CALFED could initiate experiments to determine the effect of gate operations under variable export, outflow, and tidal conditions.

> **Operation rule:** The default position of the Delta Cross Channel should be open in October and November unless there are compelling reasons to close the gates for fisheries protection.

Increase export pumping flexibility. This action can be used to improve water quality in two ways. First, the action could create new water for subsequent outflow enhancements, and second, the action could allow exports to selectively withdraw water during high quality periods with a corresponding decrease in low quality periods. Exports and in-Delta diversions can be timed to avoid elevated levels of salinity and/or organic carbon, two of the primary constituents of concern in source water for drinking water suppliers. Significant improvements in Delta water are not needed 100% of the time if selective exports are used to improve the quality of delivered water.

> ***Example***: More flexible pumping capacity could lower exports in the fall when salinity is typically the highest in all but the wettest years and allow higher exports in the winter or spring months when quality (especially salinity) is much better. In the south Delta, organic carbon typically peaks for 3-4 weeks in late February-early March. Avoidance of these elevated levels of organic carbon could reduce the annual export load by about 5%. The Environmental Water Account gaming (Spring 1999) showed that there is also a benefit to Delta fisheries in many years when exports are reduced in this period.

> **Operation rule:** Use the expanded pumping capacity at Banks Pumping Plant and joint point of diversion to export more water under high-quality conditions. The

increased capacity could also be used to make up foregone exports later in the water year when exports were reduced under high saline conditions or during the February-March period when organic carbon concentration in the Delta was high. Studies show that yield can be preserved while quality improves under most water years. When used with additional storage, flexible export operations could be coordinated to improve delivered water quality by selectively exporting for storage and/or delivery.

Increase storage. Additional storage has been shown in recent CALFED studies to significantly improve water quality if operated for this purpose. Additional storage can take the form of surface storage (new facilities or larger capacity of existing ones) or development of new groundwater.

Example: Additional north of Delta storage could be used to increase outflow to lower the occurrences and duration of elevated Delta salinity. South of Delta storage could be used in conjunction with a more flexible export/diversion pumping regime to selectively divert high-quality water to newly available storage facilities. Isolation of high-quality supplies in reservoirs for direct delivery to specific users, especially in extended dry periods, may also be an option.

Operation rule: Dedicate new storage to increase Delta outflow (a direct water quality benefit) or to assist selective water quality exports from the Delta (an indirect water quality benefit by preserving yield).

Load reduction programs or load management programs. Reduction/management programs addressing organic carbon loads in the Central Valley and in the Delta in winter and summer can be a great benefit. Routing agricultural drains or holding water for discharge on outgoing tides in the Delta or for periods of high flows on the San Joaquin River can provide benefits.

Example: CALFED should consider drainage management programs in the Delta which could consolidate, move and/or treat agricultural drainage. Drainage management programs involving drainage from Veale Tract and Byron Tract (Reclamation District 800) are being actively considered by CALFED. These programs would directly benefit the source water quality of CCWD. Other programs could improve water quality in Clifton Court Forebay and in the source water of the North Bay Aqueduct.

Regional blending. Exchanges of higher quality water among water users using available supplies could reduce diversions from the Delta during some periods and could provide substantial water quality benefits. Regional blending/water exchanges can result in improved water quality and net benefits for fisheries.

Example: There are exchange possibilities among Bay Area urban water suppliers and between MWD and Friant users. The near-term possibilities depend to some

extent on the degree to which relatively minor infrastructure/intertie facility projects are constructed.

Water purchases. Water purchases can offset losses to supply caused by fish protection or water quality actions. Benefits in many areas may occur depending on the location and timing of the purchase.

Example: Purchases for upstream flow enhancement can be used to recover foregone exports which were performed for water quality purposes or for Delta outflow.

Operation rule: If funding were available, water purchases could be made (structured as an option) to provide the same benefits as additional storage. Options would be initiated in October and called before April, although in dry years this action may be limited.

Improved water treatment. Funding for pilot programs and implementation of improved water treatment technologies such as low pressure membranes and ultraviolet disinfection, if shown to be cost-effective, would further help urban agencies meet existing and future drinking water regulations.

Water quality baseline: The baseline is important for establishing a datum to measure water quality benefits and impacts. The base condition recommended by the California Urban Water Agencies is the Delta water quality that results from the 1994 Bay-Delta Accord and upstream AFRP actions. Quantifying the baseline must partially rely on modeling studies because of the limited historical record since the implementation of the flow-related provisions of the Accord (1995-1999 only).

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